C3 cont.

36. (New) Carbon foam, comprising:

an open-celled structure produced by heating coal particles having a free swell index between about 3.5 and about 5 in a pressure controlled reactor above about 300°C, at a pressure ranging up to about 500 psi, and under a non-oxidizing atmosphere, wherein the carbon foam has a density ranging from about 0.1 to about 0.6 g/cm^3.

37. (New) The carbon foam of claim 36 wherein the carbon foam has a thermal conductivity below about 1 W/m K.

38. (New) The carbon foam of claim 36 wherein the carbon foam exhibits pore sizes below about 500 μm.

REMARKS

In response to the Office Action, claims 1-17, and 20 have been cancelled, claims 18 and 19 have been amended, and claims 21-38 have been newly added. Accordingly, claims 18, 19, and 21-38 are now pending in this application, of which, claims 18, 19, 21, 27, 33, and 36 are independent. No new matter has been added to the application. Support for the added claims may be found at least at page 5, lines 1-11; page 6, lines 13-23; page 7, lines 1-11; Example 1; and Figures 2 and 3.

Based on the above Amendments and the following Remarks, Applicant respectfully requests that the Examiner reconsider the outstanding objections and rejections and that they be withdrawn.

Preliminary Matters – Interview Summary

Applicant wishes to thank the Examiner for the interview of January 8, 2003. During the interview, the method for making carbon foam and the resulting carbon foam of the present invention was discussed with the Examiner. In particular, an aspect of the present invention directed to a method for making carbon foam where bituminous coal particles are heated in a mold to a temperature above about 300°C at a pressure up to about 500 psi to form carbon foam. The resulting product is a carbon foam material that inherently contains impurities that were present in the coal particles, such as, e.g., ash and possibly sulfur.

The cited references were discussed with respect to the present invention. None of the applied references are directed to the combination of placing bituminous coal particles in a mold, heating the bituminous coal particles in the pressure controlled mold under a non-oxidizing atmosphere above about 300°C, and pressurizing the mold at a pressure up to about 500 psi to form carbon foam.

Lastly, U.S. Patent Nos. 3,111,396; 4,128,401; 5,705,139; and 5,888,469 were brought to the attention of the Examiner. These references are being supplied as part of an Information Disclosure Statement accompanying this response.

Claim Objection

In the Office Action, claim 1 was objected to because the numeral 3 should be a superscript. (Office Action at 2). The objection to claim 1 is now moot in view of the cancellation of claim 1.

Rejections Under 35 U.S.C. §103

The Examiner rejected claims 1-10 and 16-20 under 35 U.S.C. §103(a) for being unpatentable over U. S. Patent No. 3,309,437 issued to Harnett ("Harnett") in view of U. S. Patent No. 4,127,391 issued to Koppelman ("Koppelman") combined with G.B. Patent No. 1,489,690 issued to Madley *et al.* ("Madley") and the Encyclopedia of Chemical Technology, 4th ed., Vol. 6, 1993, Kirk-Othmer ("Kirk-Othmer"). (Office Action at 2 and 4). These rejections are respectfully traversed. Applicant respectfully requests reconsideration these rejection in view of the above Amendments and following Remarks.

The Present Invention

The present invention, as embodied by the claims, is directed to heating bituminous coal particles or coal particles with a free swell index between about 3.5 and 5 to a temperature above about 300°C, in a non-oxidizing atmosphere, and at a pressure ranging up to about 500 psi in a mold or pressure controlled reactor to form carbon foam. The resulting process produces carbon foam that has unique properties and inherently contains impurities such as, ash and macerals present in the coal starting material.

The present invention is a significant advancement in the production of carbon foam materials. Prior to the present invention, the production of carbon foam was expensive and yielded relatively small amounts of carbon foam. The present invention allows for the production of large quantities of carbon foam and at costs significantly lower than previous methods could realize. The invention allows for the unique properties of carbon foam to be utilized in new applications that require low cost materials or large quantities of materials, such as building materials. Additionally, due to the inventive method, the carbon foam product has

properties and compositions that are unique from prior carbon foam materials. The coal particles used in the method inherently contain impurities. Many of these impurities remain in the resulting carbon foam. Without intending to be bound by theory, it is believed that the presence of these impurities leads to unique properties for the carbon foam, such as low thermal conductivity. Further, the method of the present invention provides for making carbon foam having a predetermined density and substantially uniform pore sizes.

Turning now to the references cited by the Examiner, Applicants respectfully submit that the claimed invention is patentable over Harnett, Koppelman, Madley, and Kirk-Othmer, taken individually, or in combination with one another. Each will be differentiated in turn below.

1. Harnett

Harnett is directed to heating raw petroleum coke particles in a container to a temperature exceeding 600°C without pressure to form baked bodies such that there is minimal alteration of the pore structure between the particles. (Harnett at Columns 1-2). Applicant respectfully submits that Harnett is distinguishable from the present invention for at least the following reasons:

Harnett Does Not Heat Coal Particles

Harnett uses different materials. Harnett uses raw petroleum coke particles (column 1, lines 10-11), where the present invention, as claimed in claims 18, 19, 21, 27, 33, and 36 uses coal particles. Raw petroleum coke particles are formed from petroleum. The present invention utilizes coal particles.

Harnett Does Not Heat Under Pressure Ranging Up To About 500 psi

Harnett does not heat particles under a pressure ranging up to about 500 psi. The process of Harnett includes heating a container that may be optionally closed with a vent at the top to minimize oxidation of the bodies. (Harnett at column 2, lines 56-59). Harnett teaches away from the claimed invention by teaching to avoid pressure forming procedures. (Harnett at column 1, lines 42-50). In contrast, the present invention heats coal particles in a mold under pressure up to about 500 psi.

Accordingly, for at least the reason stated above, Harnett fails to disclose, suggest or teach the combination of elements of heating coal particles under a non-oxidizing atmosphere above about 300°C under a pressure ranging up to about 500 psi to form carbon foam as required by claims 18, 19, 21, and 27. Further, Harnett fails to disclose, suggest or teach the carbon foam material as claimed in claims 33 and 36.

2. Koppelman

Koppelman is directed to taking bituminous fines and turning them into an agglomerated coke-like product that can be used as a fuel. (Koppelman at column 8, lines 30-33). Koppelman heats bituminous fines either alone or mixed with particulated cellulosic material to at least about 750°F and at a pressure at least about 1000 psi. (Koppelman at column 5, lines27-34).

Koppelman is distinguishable from the present invention for at least the following reasons.

Koppelman Does Not Heat at a Pressure Ranging Up To About 500 psi

Kopplemen heats at a significantly higher pressure of at least about 1000 psi. (Koppelman at column 5, lines27-34). These differences in pressures have an effect on the resultant product. Koppelman is producing a body to be used as a fuel. The denser the product, the greater the heating capacity of the product. Accordingly, high pressure is used to produce a dense product. The present invention is directed to making carbon foam. In accordance with the claimed invention, the pressures for making carbon foam are below about 500 psi.

Accordingly, Koppelman fails to disclose, suggest or teach the combination of elements of heating coal particles under a non-oxidizing atmosphere above about 300°C under a pressure ranging up to about 500 psi to form carbon foam as required by claims 18, 19, 21, and 27. Further, Koppelman fails to disclose, suggest or teach the carbon foam material as claimed in claims 33 and 36, whether taken alone or in combination with Harnett.

Applicants respectfully submit that the combination of Harnett and Koppelman is improper as there is no suggestion to combine these references. As discussed above, Harnett specifically teaches away from using pressure forming procedures, where as Koppelman specifically teaches using pressure of at least about 1000 p.s.i. Accordingly, one skilled in the art would not be motivated to combine Harnett with Koppelman in view of their opposite teachings.

3. Madley

Madley is directed to making a briquetting coal by heating low-rank, high volatile coal particles in a fluidized bed reactor in the presence of oxygen followed by heating to 600 to 900°C. The coal is then added to caking coal for briquetting by using for example, a double roll press. (Madley at columns 1-2). Madley is distinguishable from the present invention for at least the following reasons.

Madley Does Not Heat in a Non-Oxidizing Atmosphere

Madley heats particles in oxygen. Accordingly, Madley does not use a non-oxidizing atmosphere as required by the claimed invention.

Madley Does Not Produce Carbon Foam

Further, Madley does not produce carbon foam. Madley produces briquetting coal, which can be used to form coal briquettes. In contrast, the claimed invention is directed to carbon foam.

Accordingly, Madley fails to disclose, suggest or teach the combination of elements of heating coal particles under a non-oxidizing atmosphere above about 300°C under a pressure up to about 500 psi to form carbon foam as required by claims 18, 19, 21, and 27. Further, Madley fails to disclose, suggest or teach the carbon foam material as claimed in claims 33 and 36, whether taken alone or in combination with Harnett and Koppelman.

The addition of Madley does not cure the deficiencies of the combination of Harnett and Koppelman. The combination of Madley with Harnett and Koppelman would suggest that particles be heated in oxygen prior to forming coal briquettes. As discussed above, claims 18, 19, 21, and 27 heat coal particles in a non-oxidizing atmosphere. Accordingly, the combination of Harnett, Koppelman, and Madley, even if proper, would not teach or suggest the claimed invention.

4. Kirk-Othmer

Kirk-Othmer is directed to coal caking properties that make a good quality coke. (Kirk-Othmer at page 455). Kirk-Othmer is distinguishable from the present invention for at least the following reasons:

Kirk-Othmer Does Not Heat at a Pressure Ranging Up To About 500 psi

Kirk-Othmer does not heat coal particles under a pressure ranging up to about 500 psi as required by the claimed invention. Kirk-Othmer describes properties of coal that make a good coke and describes a test where coal is heated in an open crucible.

Kirk-Othmer Does Not Form Carbon Foam

Kirk-Othmer teaches forming **coke**, not carbon foam. Coke is a fairly dense mass that has non-uniform, irregular pore sizes. In contrast, carbon foam has a substantially uniform pore structure, and is typically less dense than coke.

Accordingly, Kirk-Othmer fails to disclose, suggest or teach the combination of elements of heating coal particles under a non-oxidizing atmosphere above about 300°C under a pressure up to about 500 psi to form carbon foam as required by claims 18, 19, 21, and 27. Further, Kirk-Othmer fails to disclose, suggest or teach the carbon foam material as claimed in claims 33 and 36, whether taken alone or in combination with Harnett, Koppelman, and Madley.

The addition of Kirk-Othmer does not cure the deficiencies of the combination of Harnett, Koppelman, and Madley. The addition of Kirk-Othmer to the combination of Harnett, Koppelman, and Madley does not suggest heating coal particles under a non-oxidizing atmosphere above about 300°C under a pressure rangin up to about 500 psi to form carbon foam as required by claims 18, 19, 21, and 27 or the carbon foam material as claimed in claims 33 and 36

For at least the foregoing reasons, Applicant respectfully requests that the rejection over claims 18 and 19 be withdrawn. Further, Applicant repsectfully submits that claims 21, 27, 33, and 36 are patentable over the cited references. Claims 22-26, 28-32, 34-35, and 37-38 are dependent claims that depend from claims 21, 27, 33, or 36 and are likewise patentable over the cited references.

Lastly, claims 11-15 stand rejected under 35 U.S.C. §103(a) for being unpatentable over Harnett in view of Koppelman combined with Madley and Kirk-Othmer, and further in view of JP-O 811,287,619A to Kuroda ("Kuroda"). (Office Action at 4). By the present amendment claims 11-15 have been cancelled.

Patents In The Information Disclosure Statement

U.S. Patent Nos. 3,111,396; 4,128,401; 5,705,139; and 5,888,469 are directed to making foam materials. None of the disclosed patents teach or suggest heating coal particles in a mold under a non-oxidizing atmosphere above about 300°C and under a pressure up to about 500 psi, to form carbon foam, or the carbon foam made by this method as required by the claimed invention.

Other Matters

This reply is accompanied by a petition for a three (3)-month extension of time. It is not believed that any further extensions of time or fees for net addition of claims are required other than the accompanied petition. However, if additional extension of time are necessary to prevent abandonment of this application, then such extensions of time are hereby petitioned under 37 C.F.R. §1.136(a), and any fees required therefor (including fees for net addition of claims) are hereby authorized to be charged to our Deposit Account No. 23-1951.

CONCLUSION

All of the stated grounds of objection and rejection have been properly traversed, accommodated, or rendered moot. Applicants therefore respectfully request that the Examiner reconsider all presently outstanding objections and rejections and that they be withdrawn. Applicants believe that a full and complete response has been made to the outstanding Office Action and, as such, claims 18, 19, 21-38 are in condition for allowance. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

Prompt and favorable consideration of this Reply is respectfully requested.

Respectfully submitted,

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APPENDIX A

The "marked-up" version of the added paragraph is as follows.

-- The U.S. Government has a paid-up license in this invention and the right in limited circumstances to require the patent owner to license other on reasonable terms as provided for by the terms of contract no. N00014-00-C-0062 awarded by Office of Naval Research. --

APPENDIX B

The "marked-up" version of the amended claims is as follows:

18. (Amended) A [coal-based] carbon foam produced by [the direct] heating [of] comminuted coal particles under pressure ranging up to about 500 psi in a pressure controlled mold and under a non-oxidizing atmosphere to a temperature ranging from about 300°C to about 700°C.

19. (Amended) A method for producing carbon foam, comprising the steps of:

placing comminuted coal particles in a pressure controlled mold; and

[directly] heating the comminuted coal particles under pressure ranging up to about 500 psi [in a pressure controlled mold] to a temperature ranging from about 300°C to about 700°C, thereby producing carbon foam.